Introduction to AI and Machine Learning

Amanda Doucette
Software Engineer

Originate

1. What is AI and machine learning?
    - Supervised Learning (Some math here. Don’t worry.)
    - Unsupervised Learning
    - Reinforcement Learning
2. Will robots take over the world?
3. What are the actual problems with AI?

What is artificial intelligence?

1. a branch of computer science dealing with the simulation of intelligent behavior in computers

What is artificial intelligence?

1. a branch of computer science dealing with the simulation of intelligent behavior in computers

2. the capability of a machine to imitate intelligent human behavior

What is machine learning?

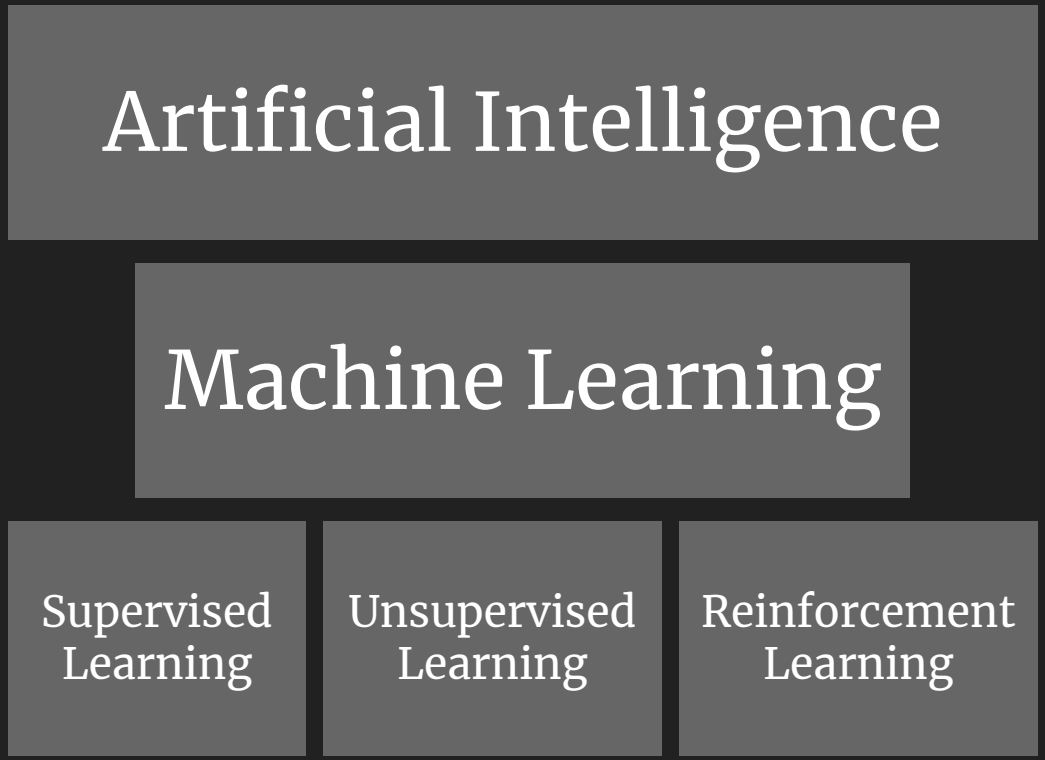
the process by which a computer is able to improve its own performance by continuously incorporating new data into an existing statistical model

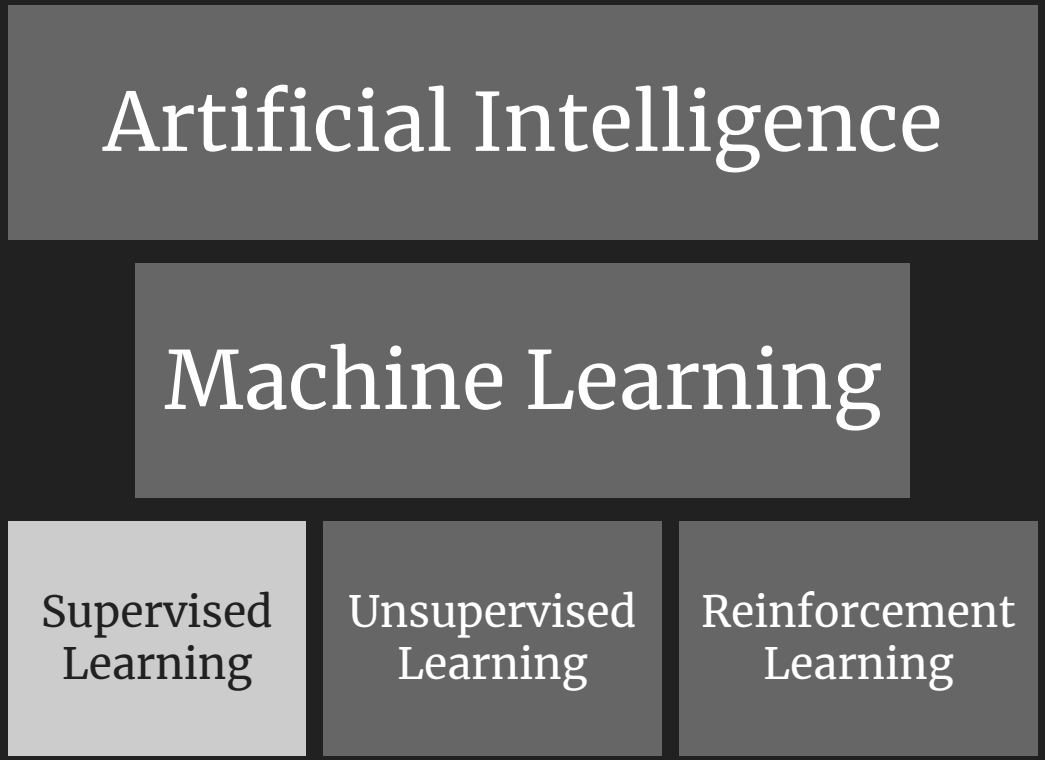
Artificial Intelligence

$$f(input) = output$$

Machine Learning

$$?(input) = output$$


Artificial Intelligence
Machine Learning
Supervised Learning
Unsupervised Learning
Reinforcement Learning


Artificial Intelligence
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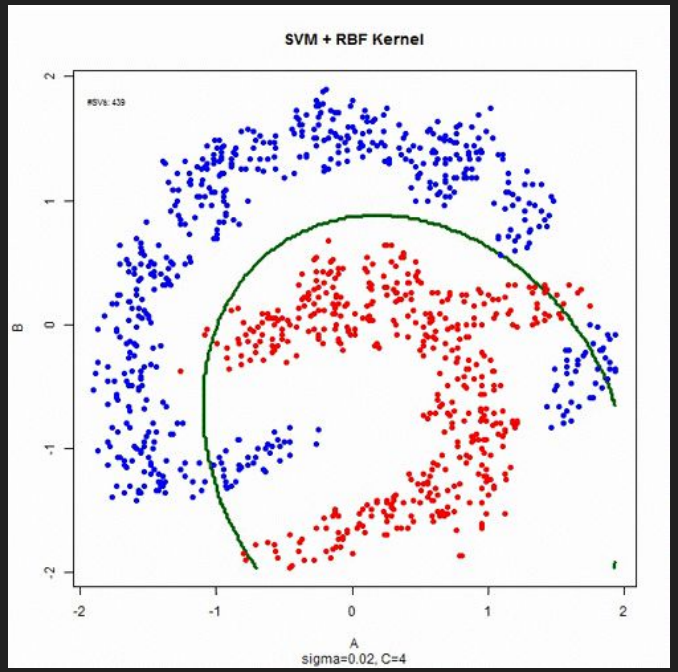
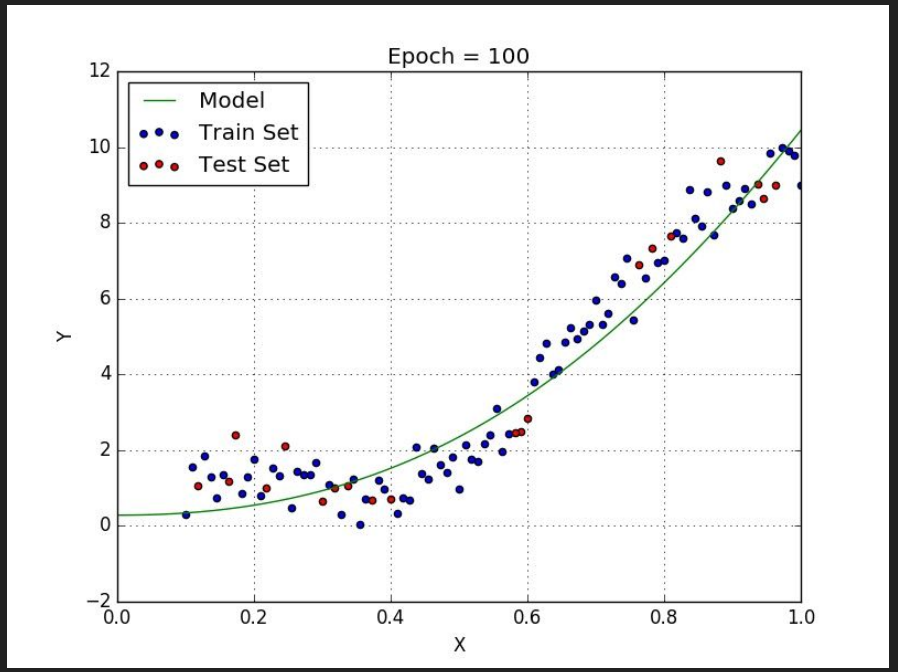
What is supervised learning?

Given a set of inputs with known outputs, learn the mapping from input to output

Classification



Regression



https://histalk2.com/2018/10/24/a-machine-learning-primer-for-clinicians-part-2/
https://www.cs.toronto.edu/~frossard/post/multiple_linear_regression/

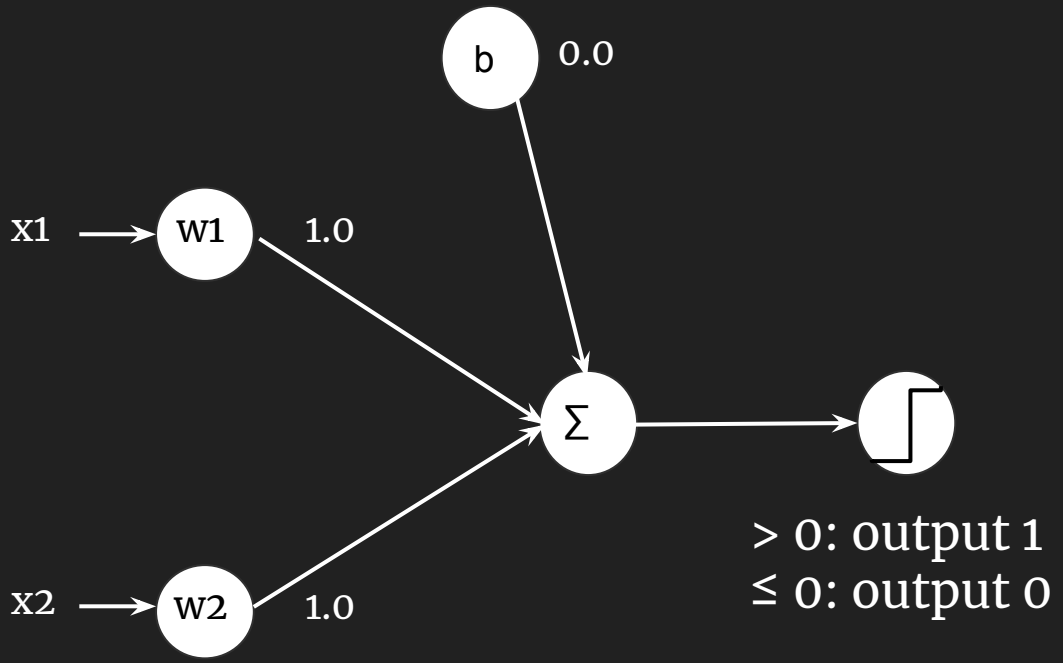
Originate

The Perceptron Classifier

- A simple classifier inspired by neuron cells
- Makes classification decisions with a weighted sum of inputs, and a threshold function

Perceptron Classifier

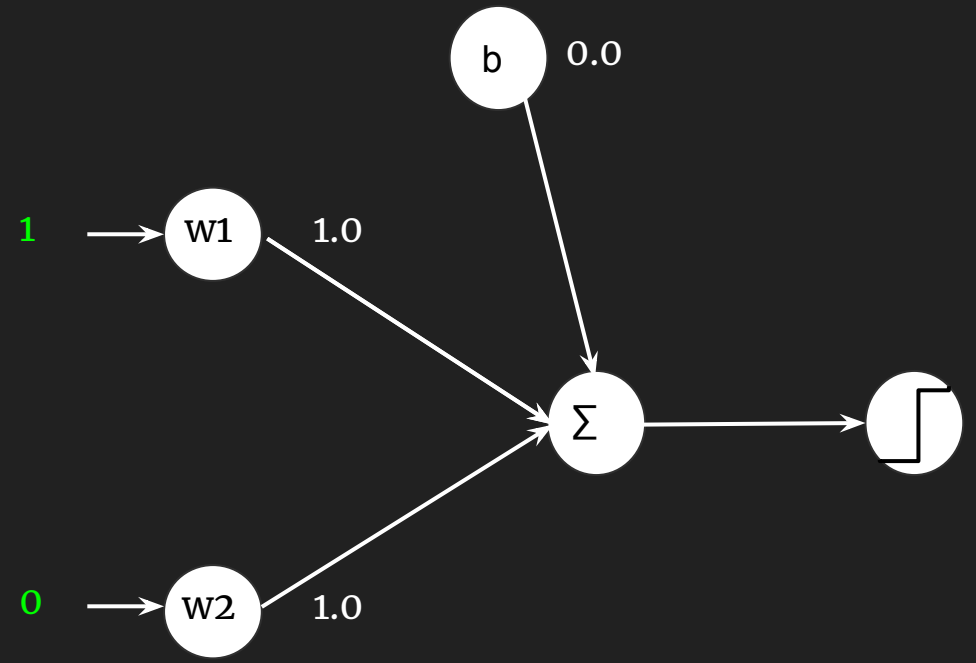
x1	x2	y
1	0	0
0	1	0
1	1	1
0	0	0



$$x1(w1) + x2(w2) + b$$

Perceptron Classifier

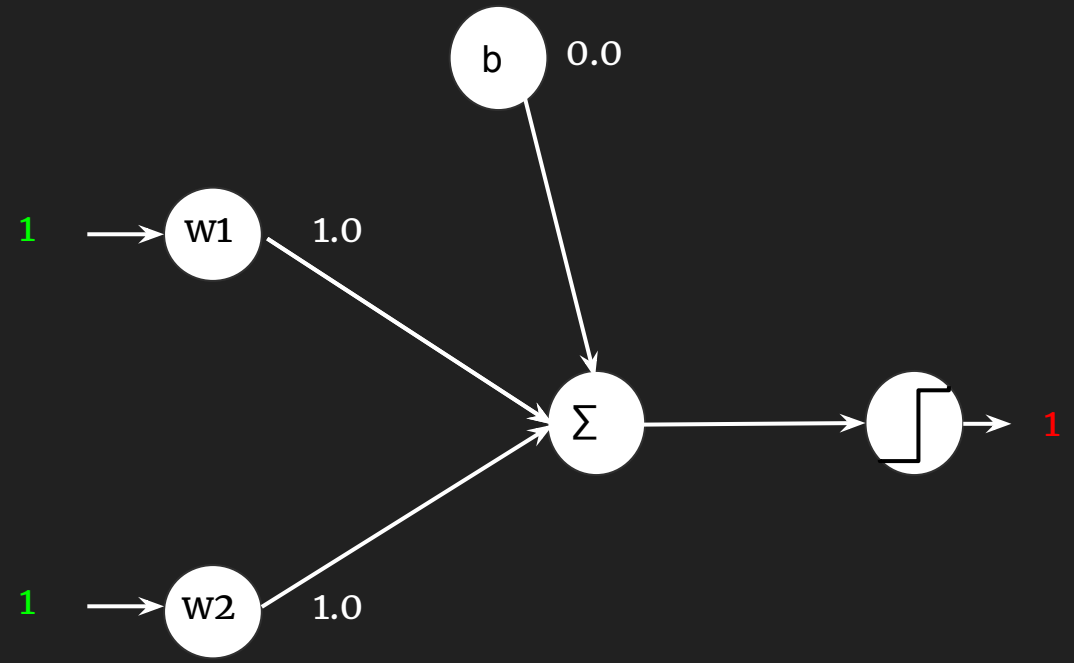
x1	x2	y
1	0	0
0	1	0
1	1	1
0	0	0



$$x1(w1) + x2(w2) + b \quad = \quad 1(1.0) + 0(1.0) + 0.0 \quad = \quad \mathbf{1.0}$$

Perceptron Classifier

x1	x2	y
1	0	0
0	1	0
1	1	1
0	0	0

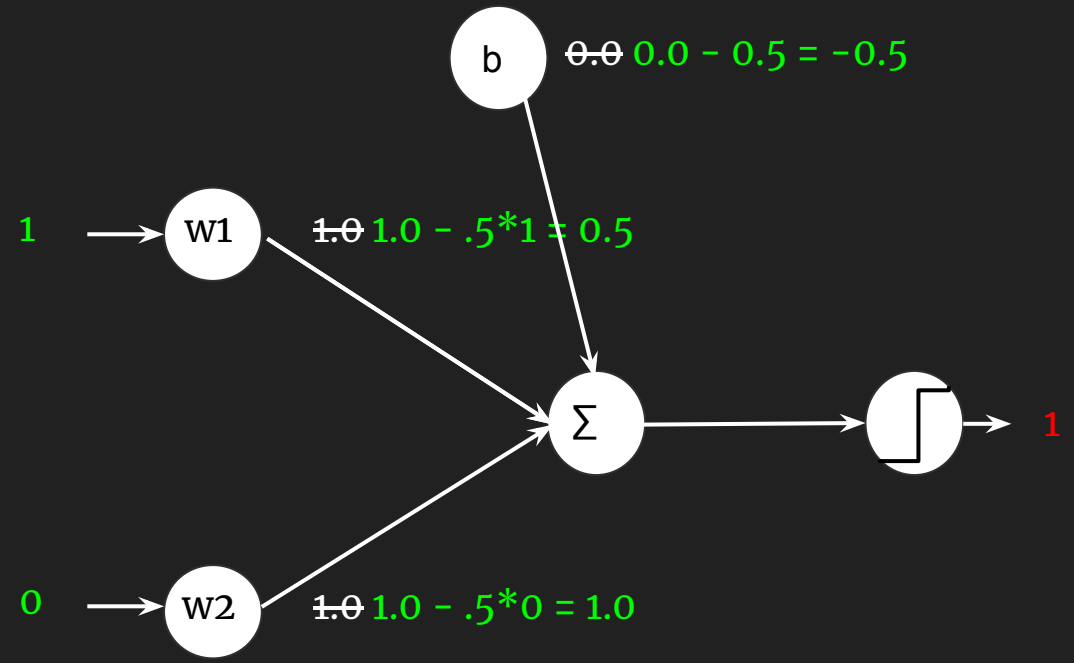


$$x1(w1) + x2(w2) + b \quad = \quad 1(1.0) + 0(1.0) + 0.0 \quad = \quad 1.0 \leq 0.0$$

Perceptron Classifier

Update rule: w = w - 0.5(x)

x1	x2	y
1	0	0
0	1	0
1	1	1
0	0	0



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Perceptron Classifier

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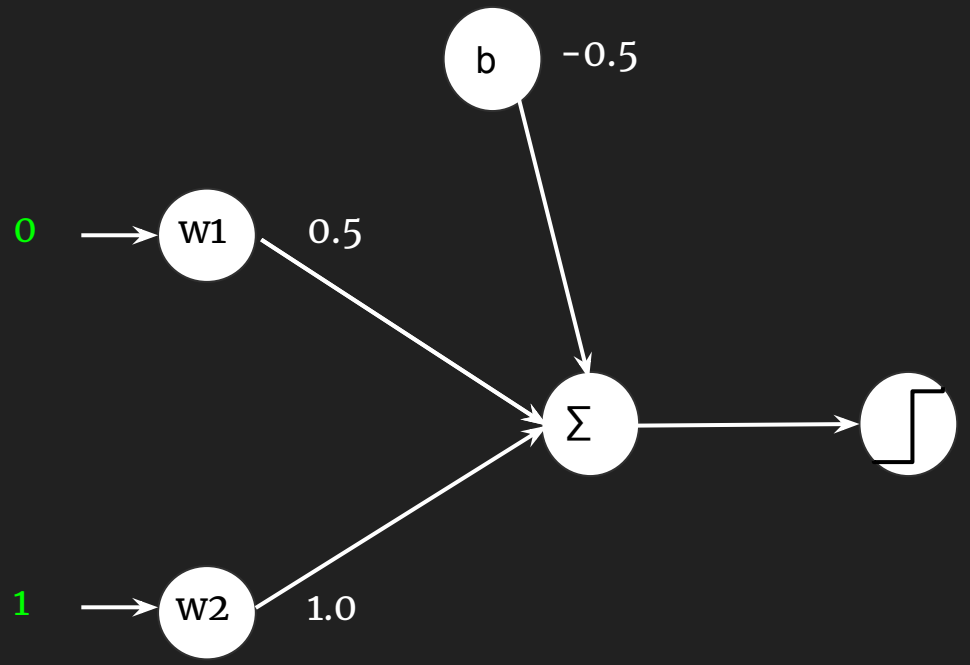

$$x1(w1) + x2(w2) + b = 0(0.5) + 1(1.0) - 0.5 = \mathbf{0.5}$$

Perceptron Classifier

x1	x2	y
1	0	0
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1	1	1
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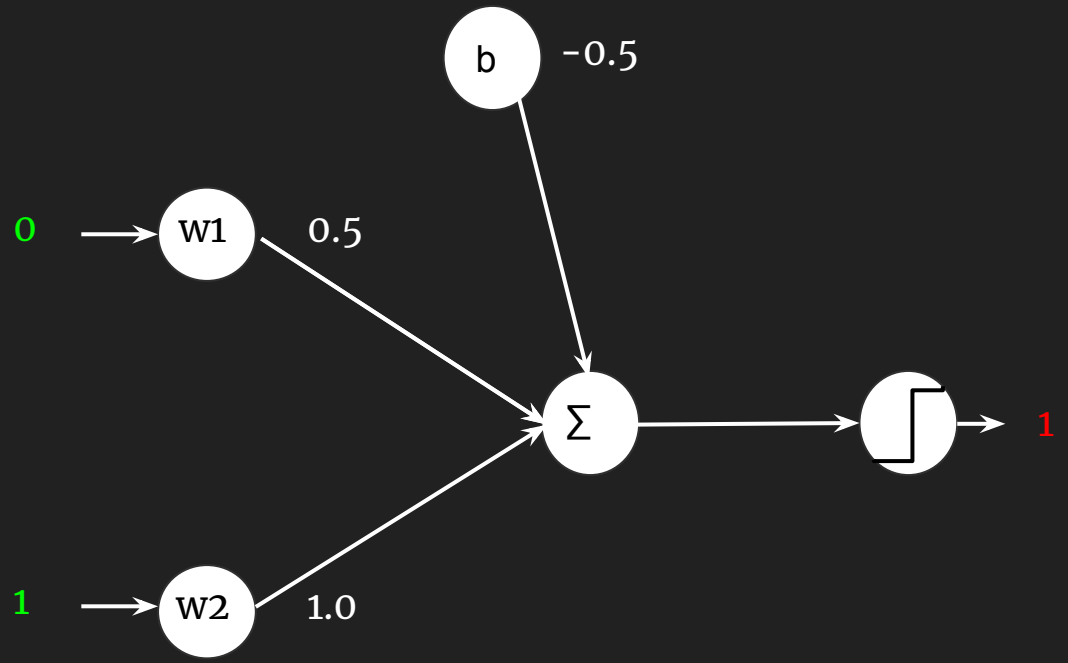

$$x1(w1) + x2(w2) + b = 0(0.5) + 1(1.0) - 0.5 = 0.5 \leq 0.0$$

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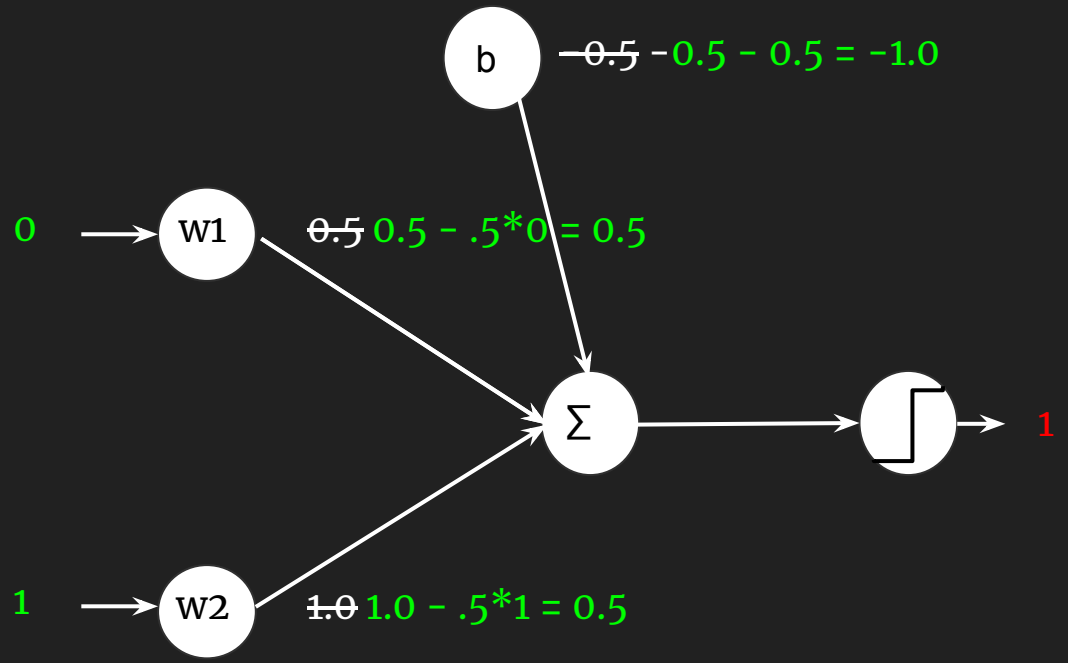

x1(w1) + x2(w2) +b = 0(0.5) + 1(1.0) - 0.5 = 0.5 ≤ 0.0

Perceptron Classifier

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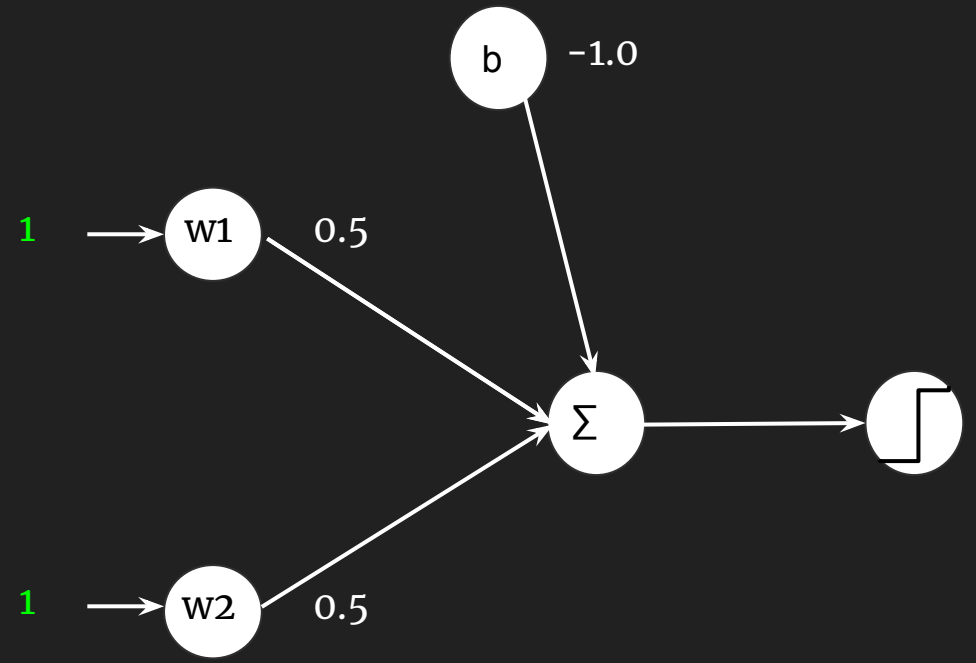

$$x1(w1) + x2(w2) + b = 1(0.5) + 1(0.5) - 1.0 = \mathbf{0.0}$$

Perceptron Classifier

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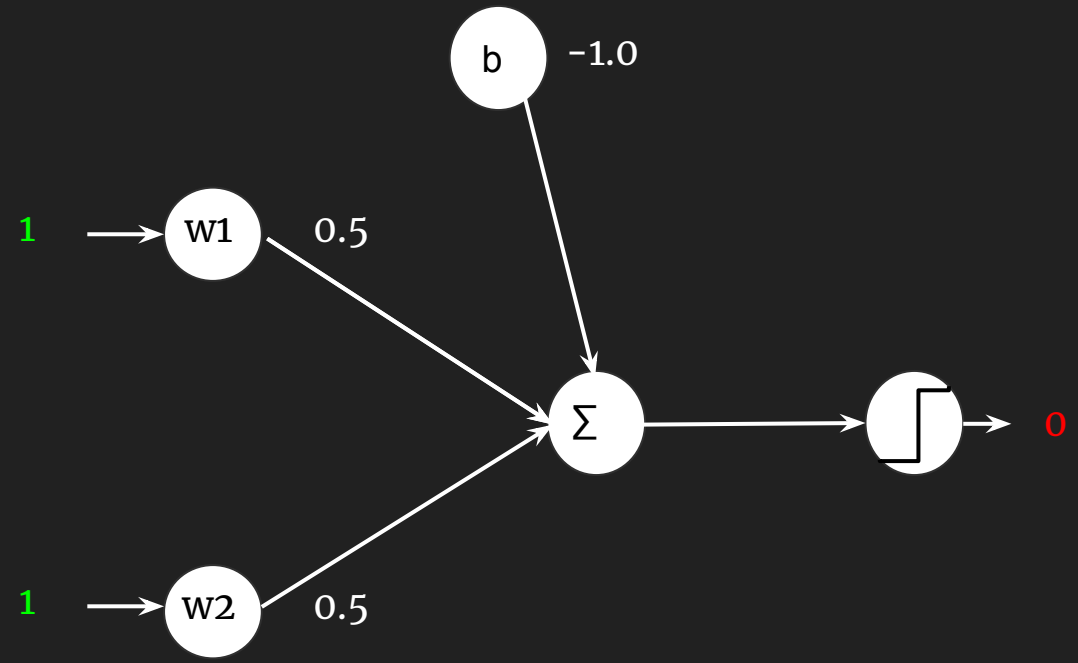
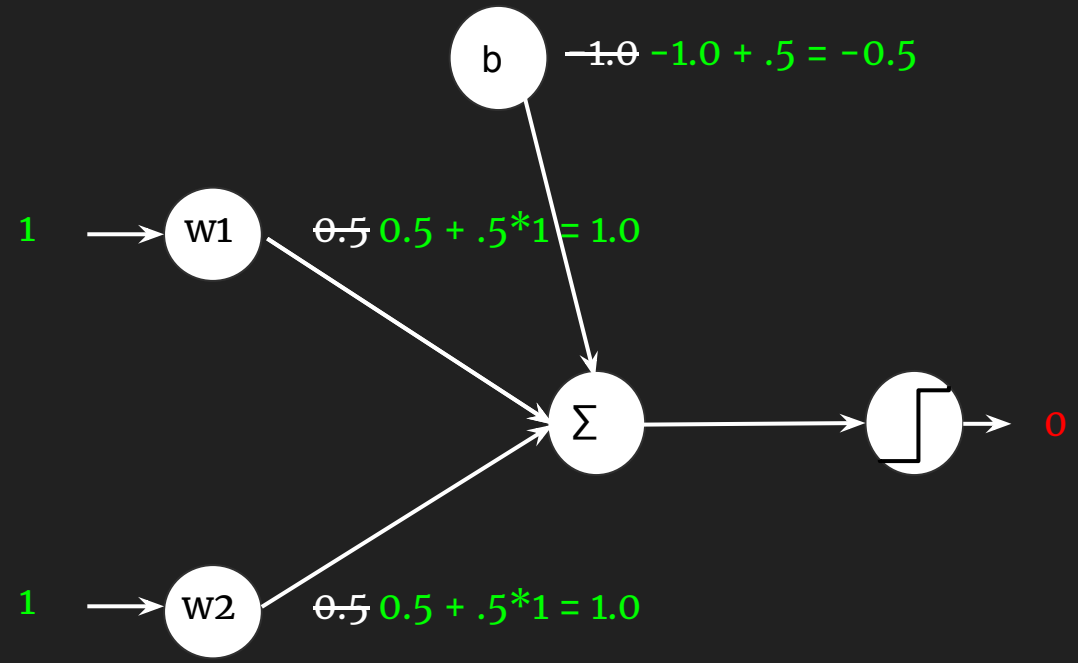


$$x1(w1) + x2(w2) + b = 1(0.5) + 1(0.5) - 1.0 = 0.0 > 0.0$$

Perceptron Classifier

Update rule: w = w + 0.5(x)

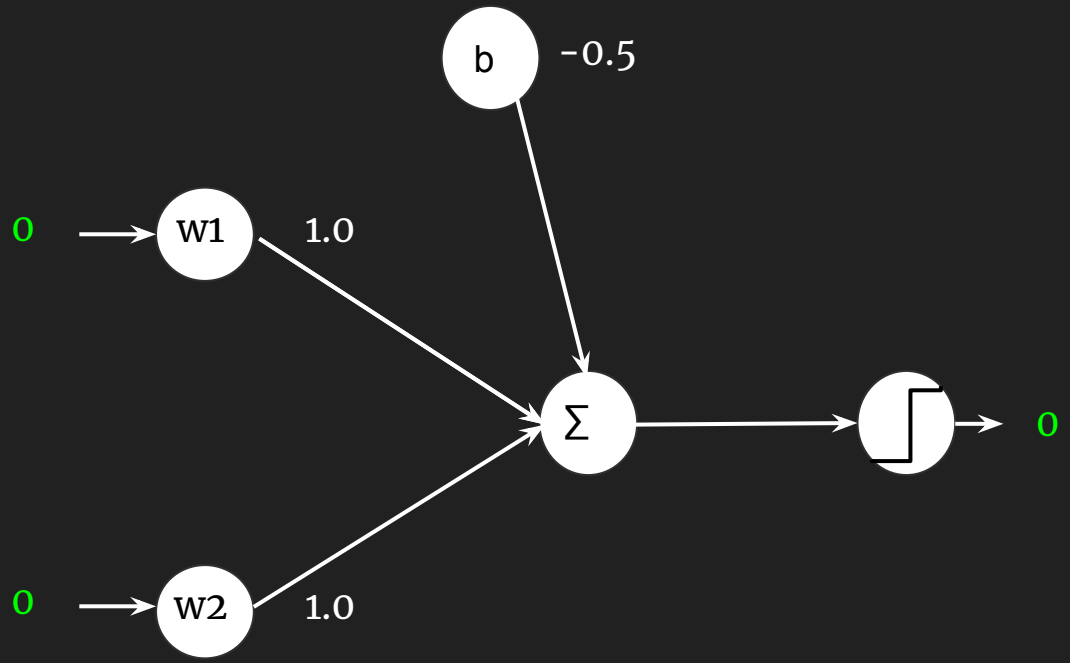
x1	x2	y
1	0	0
0	1	0
1	1	1
0	0	0



x1(w1) + x2(w2) +b = 1(0.5) + 1(0.5) - 1.0 = **0.0 > 0.0**

Perceptron Classifier

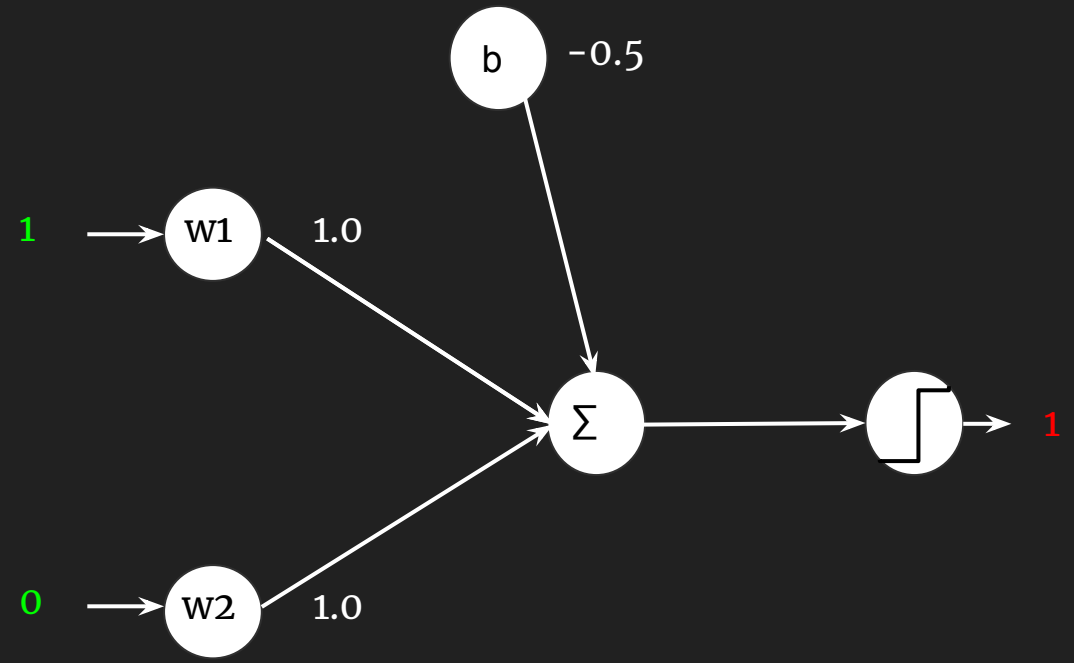
x1	x2	y
1	0	0
0	1	0
1	1	1
0	0	0



$$x1(w1) + x2(w2) + b = 0(1.0) + 0(1.0) - 0.5 = -0.5 \leq 0.0$$

Perceptron Classifier

x1	x2	y
1	0	0
0	1	0
1	1	1
0	0	0



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Perceptron Classifier

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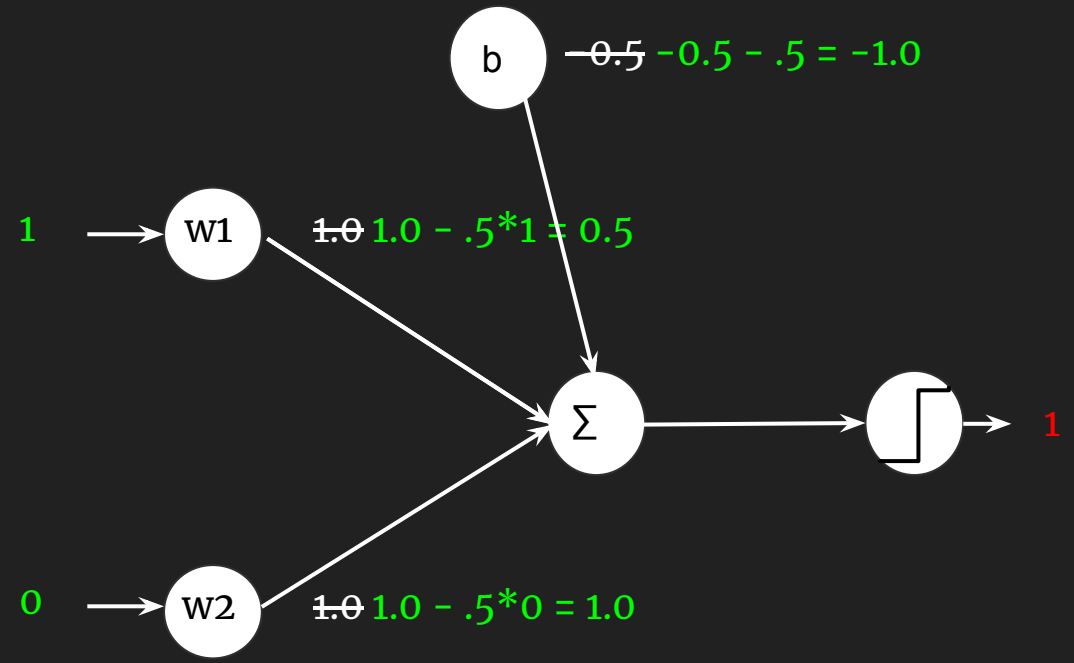

x1(w1) + x2(w2) +b = 1(1.0) + 0(1.0) - 0.5 = **0.5 ≤ 0.0**

Perceptron Classifier

x1	x2	y
1	0	0
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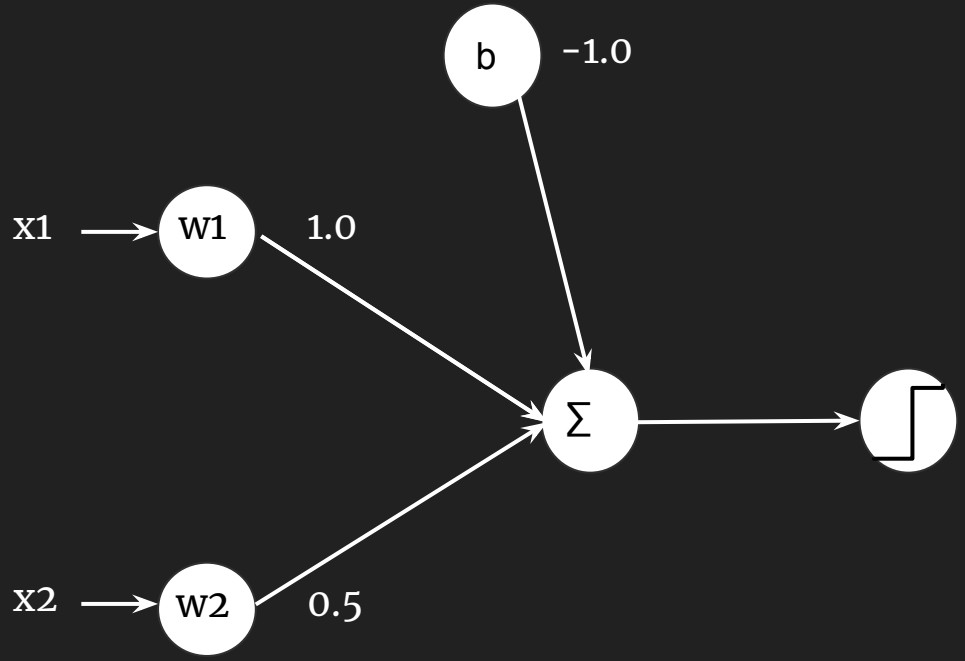


$1(1.0) + 0(0.5) - 1 = 0.0 \leq 0$
$0(1.0) + 1(0.5) - 1 = -0.5 \leq 0$

$1(1.0) + 1(0.5) - 1 = 0.5 > 0$
$0(1.0) + 0(0.5) - 1 = -1.0 \leq 0$

Neural Networks

Just a bunch of perceptrons (and variations) connected together in different configurations.

larger network = learn more complex patterns

Perceptron demo

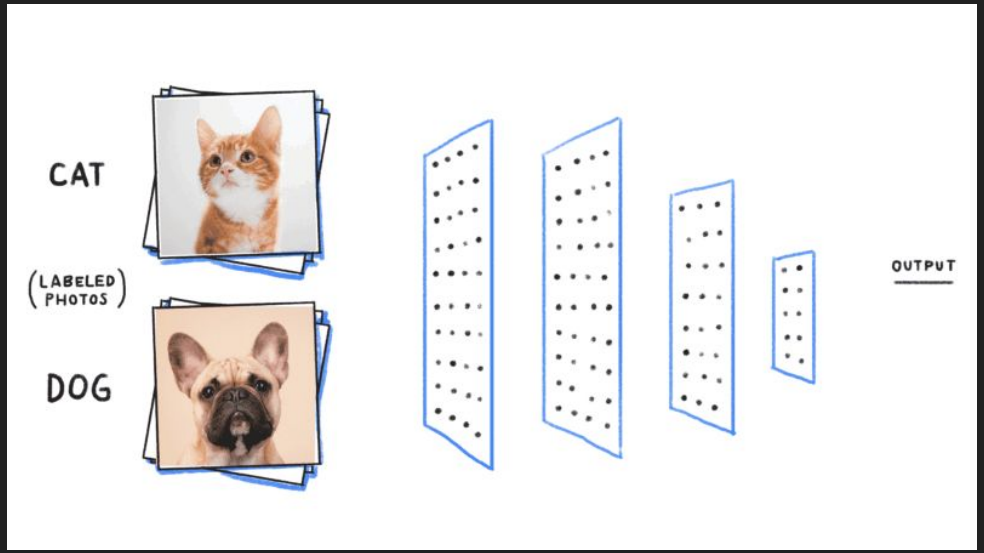
Neural network demo

Supervised Learning

Learning an input-output mapping from data represents a huge portion of machine learning technology.

Image Classification

$$f(image) = label$$

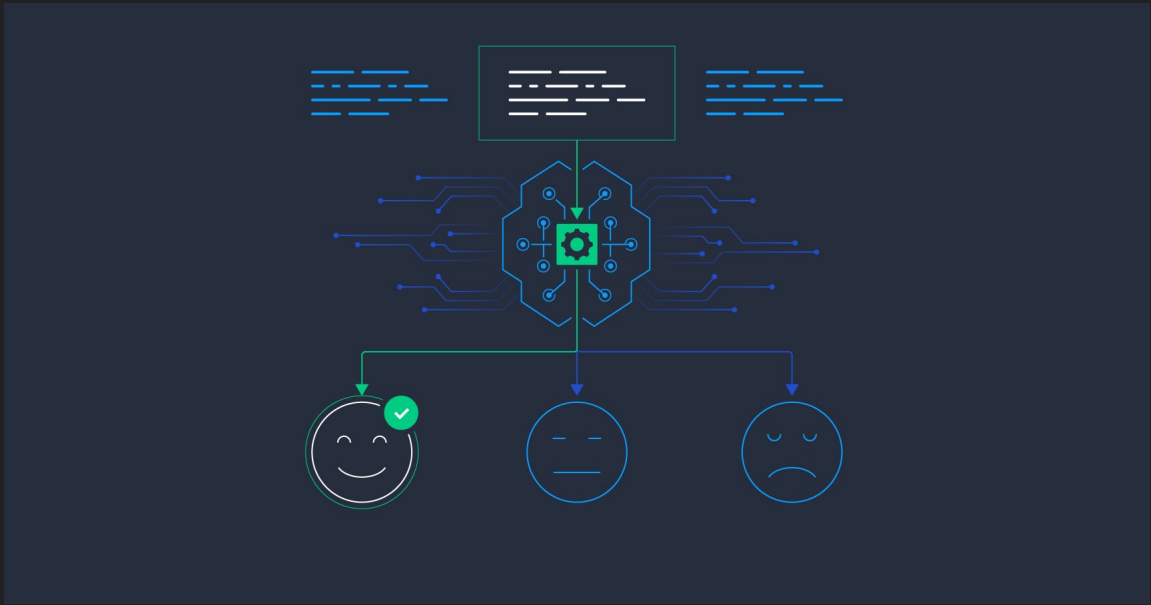


https://medium.com/datadriveninvestor/how-a-computer-looks-at-pictures-image-classification-a4992a83f46b

Originate

Sentiment Analysis

f(text) = positive/negative score



https://www.toptal.com/deep-learning/4-sentiment-analysis-accuracy-traps

Originate

Speech Recognition

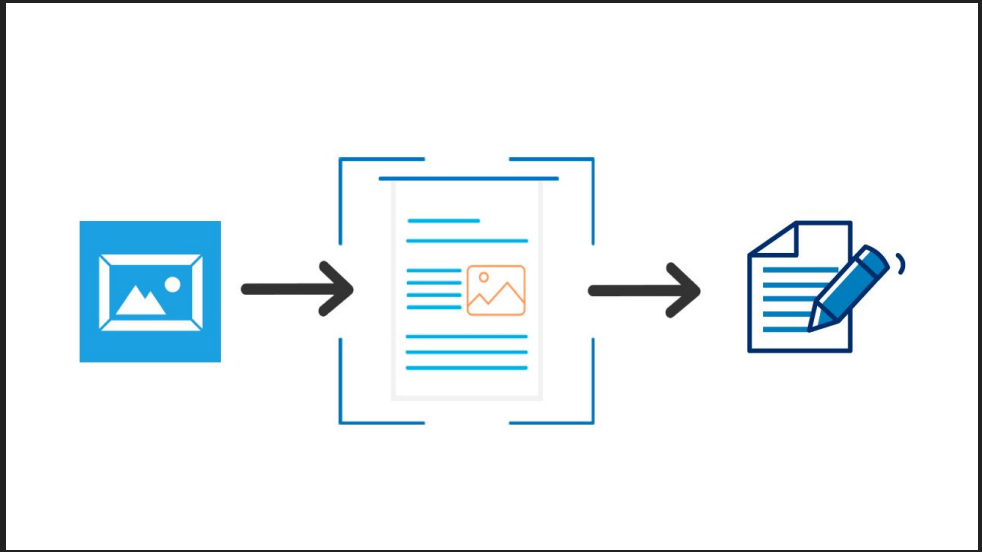
$$f(audio) = text$$

https://colab.research.google.com/drive/1fXJ_YUWACs0w8ohORFijuWo4_pCLMIEK

Originate

Optical Character Recognition

$$f(image) = text$$

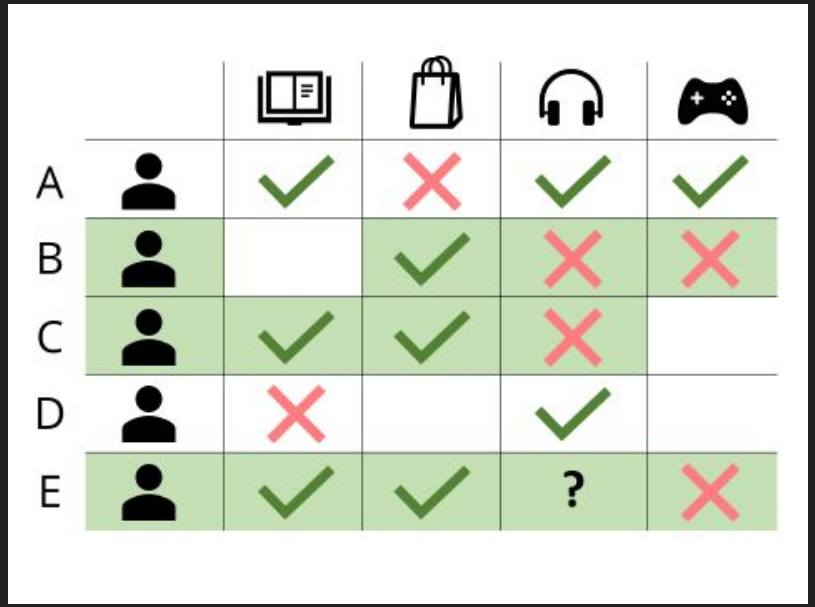


https://medium.com/@sidathasiri/what-is-ocr-and-how-does-it-work-a48540d16958

Originate

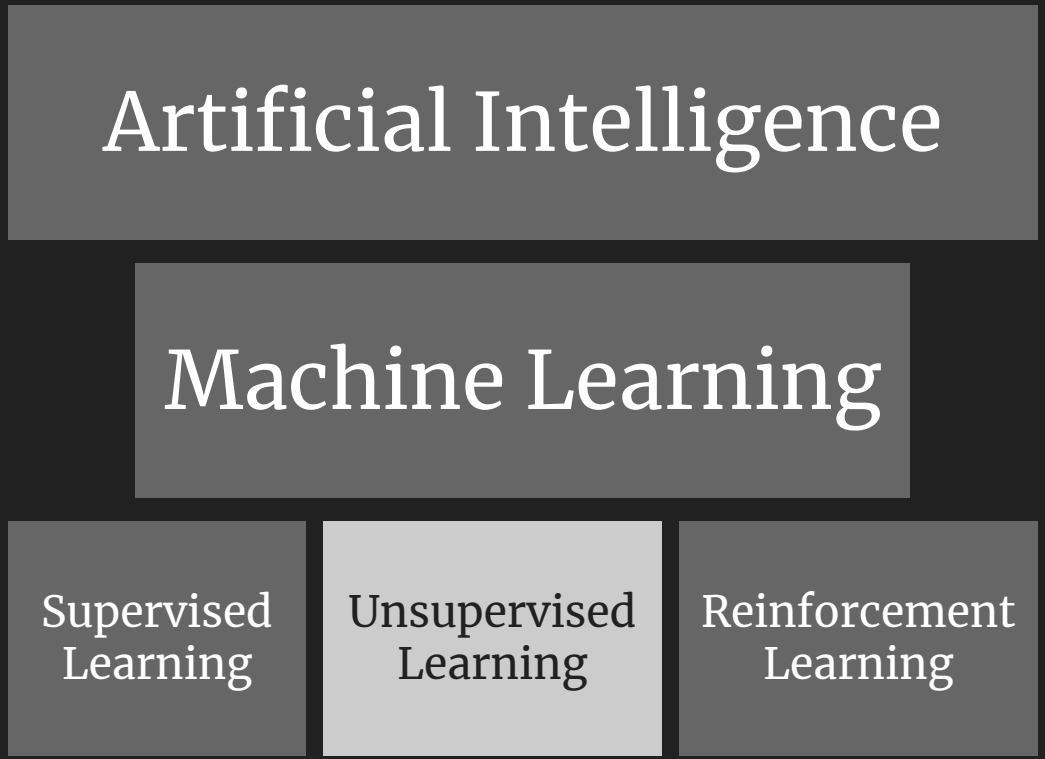
Recommender Systems

f(person x, thing y) = will x like y?



https://www.incubegroup.com/blog/recommender-system-for-private-banking/

Originate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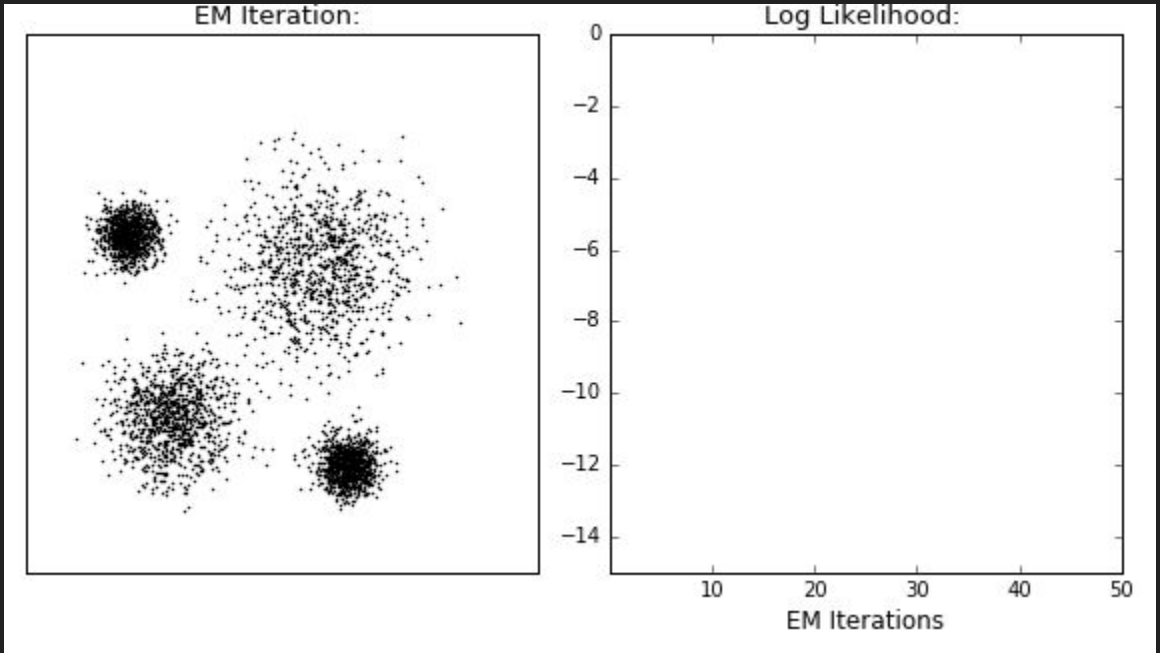
What is unsupervised learning?

Given a dataset, identify either clusters of similar data, or outliers

Also known as clustering, cluster analysis, and anomaly detection

Unsupervised Learning

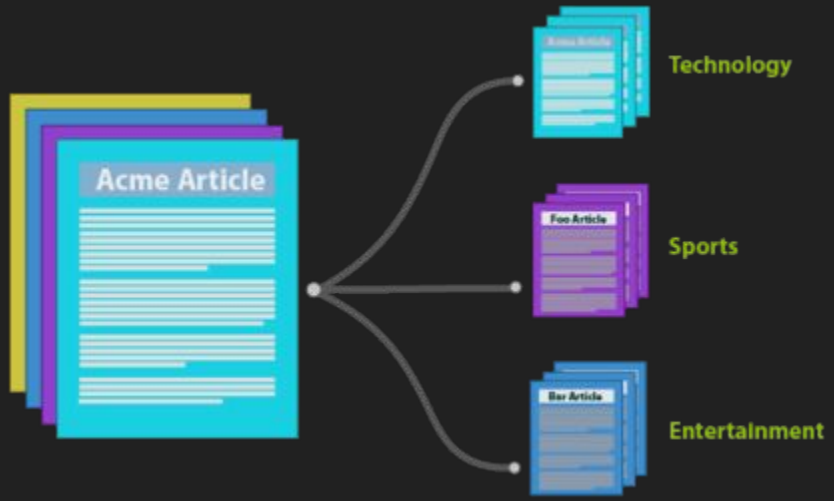


https://dashee87.github.io/data%20science/general/Clustering-with-Scikit-with-GIFs/

Originate

Document Clustering

f(text documents) = groups of related documents

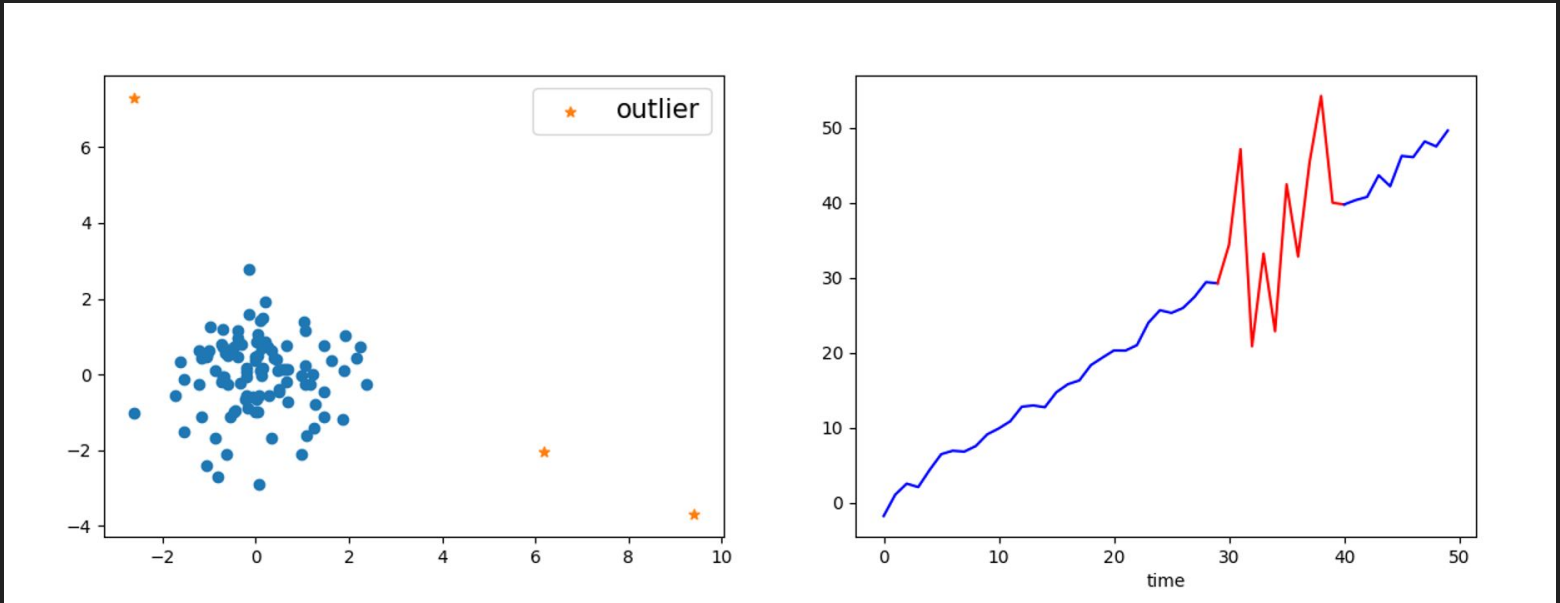


http://blog.aylien.com/text-analysis-101-a-basic-understanding-for-3/

Originate

Anomaly Detection

$f(data) = outliers$

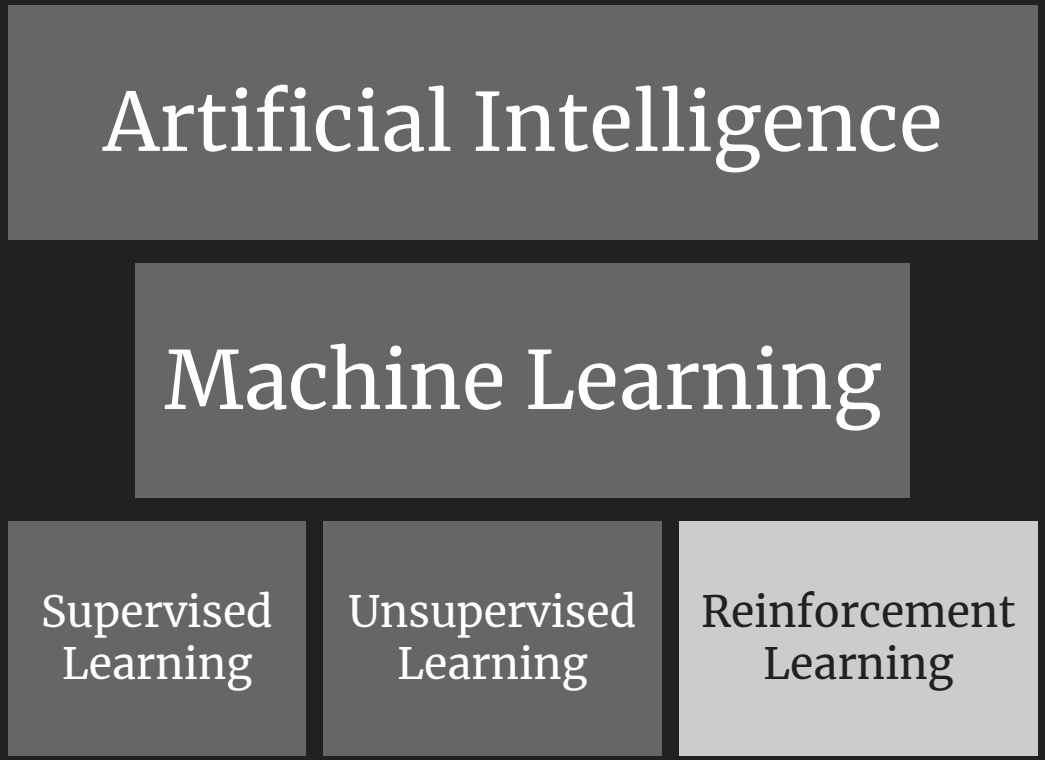


https://www.renom.jp/id/notebooks/tutorial/time_series/lstm-anomalydetection/notebook.html

Unsupervised Learning

Useful when:

- There are no existing labels associated with data
- You need to find natural groupings of a large dataset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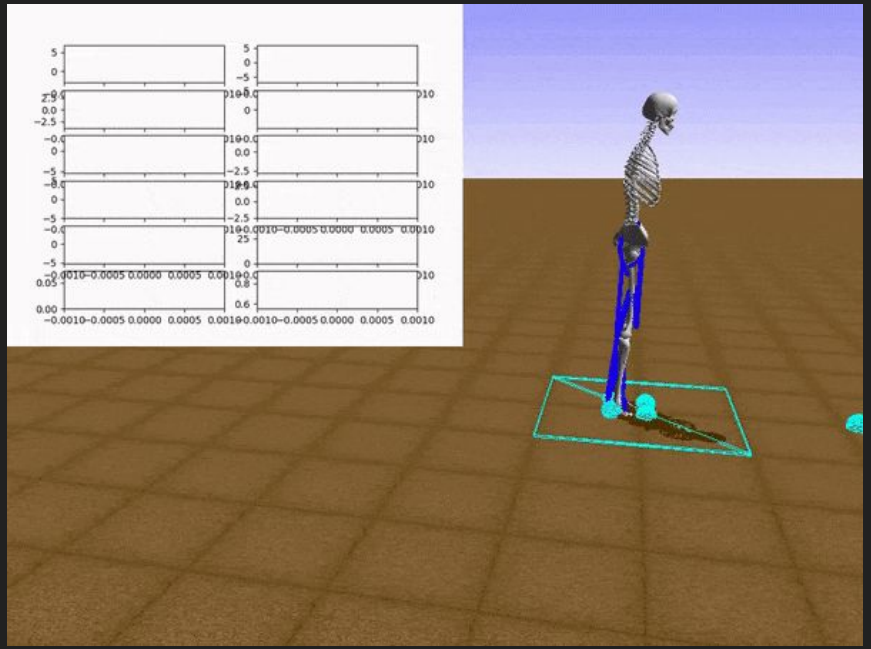
What is reinforcement learning?

An agent chooses an action to maximize expected reward in an environment.

The agent improves its future choices based on feedback from the environment.

Robotics

train a robot to walk

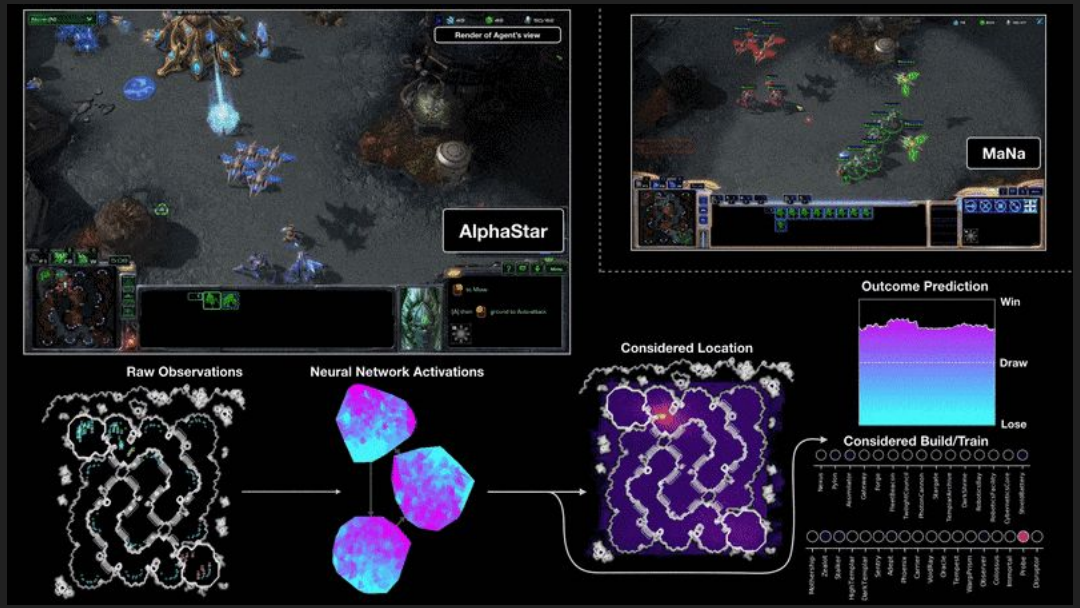


https://deepsense.ai/learning-to-run-an-example-of-reinforcement-learning/

Originate

Game Playing

train a computer to play a game



https://deepmind.com/blog/alphastar-mastering-real-time-strategy-game-starcraft-ii/

Originate

Supervised Learning

Learn a mapping from inputs to outputs.

Unsupervised Learning

Group data into similar clusters.

Reinforcement Learning

Train an agent to choose actions based on feedback from its environment.

Will human-like artificial intelligence ever exist?

Originate

"Progress in hardware has followed an amazingly steady curve in the last few decades. Based on this trend, I believe that the creation of greater-than-human intelligence will occur during the next thirty years."

- Vernor Vinge, 1993
San Diego State University

https://frc.ri.cmu.edu/~hpm/book98/com.ch1/vinge.singularity.html

Originate

“By around 2040, there will be no job that people can do better than robots.”

- Hans Moravec, 1995
  Carnegie Mellon University

https://www.wired.com/1995/10/moravec/

Originate

"Lenat is constructing a massive 'expert system.' If he succeeds, sometime around 2025 he will produce what he calls 'a generally intelligent artifact' that can think like a human."

- Douglas Lenat, 1998
  Stanford University

https://www.forbes.com/global/1998/1130/0118096a.html#43dd4bee7828

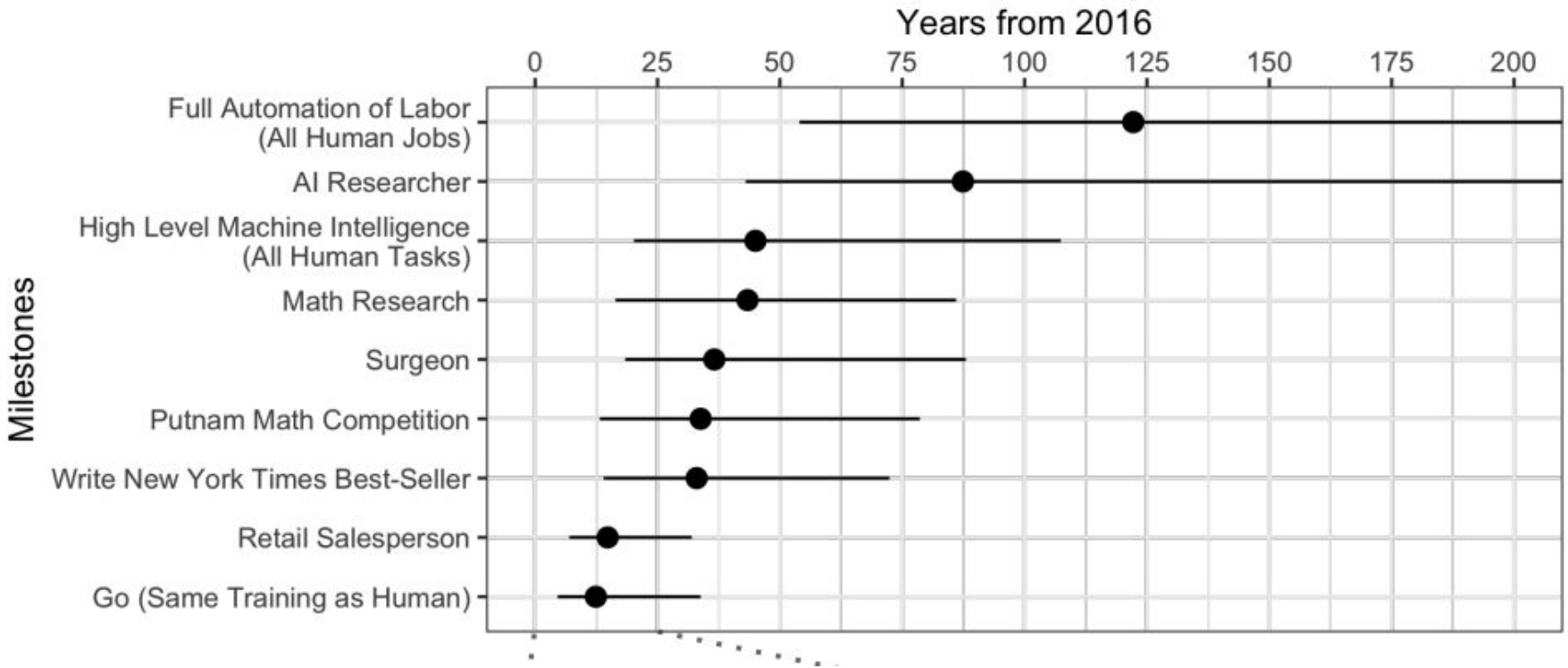
Originate

"I have consistently predicted that by 2029 we will be able to create machines that pass the Turing test."

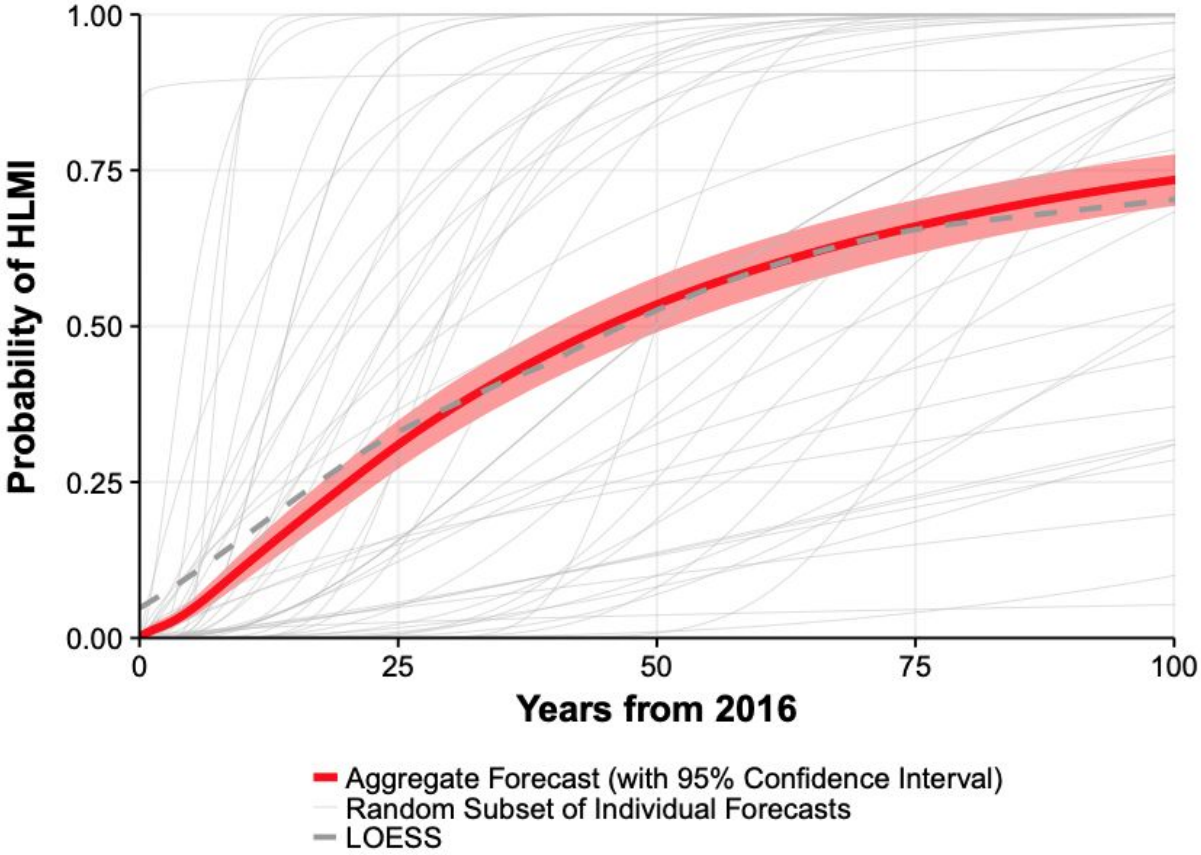
- Ray Kurzweil, 2006
  Author

https://www.newscientist.com/article/dn10620-ray-kurzweil-predicts-the-future/

Originate



https://arxiv.org/pdf/1705.08807.pdf



https://arxiv.org/pdf/1705.08807.pdf

So what are actual problems in ML?

Machine learning is not inherently unbiased.

Biased data = biased models

A herd of sheep grazing on a lush green hillside
Tags: grazing, sheep, mountain, cattle, horse

A close up of a lush green field
Tags: grass, field, sheep, standing, rainbow, man

Left: A man is holding a dog in his hand
Right: A woman is holding a dog in her hand
Image: @SouperSarah

NeuralTalk2: A flock of birds flying in the air
Microsoft Azure: A group of giraffe standing next to a tree
Image: Fred Dunn, https://www.flickr.com/photos/gratapictures - CC-BY-NC

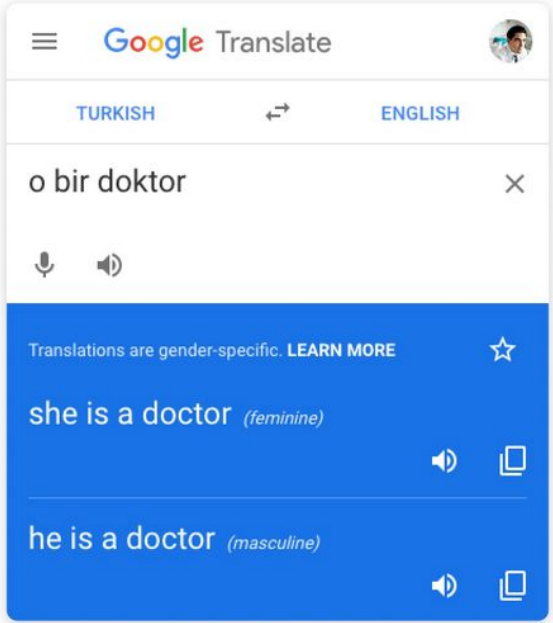
A group of orange flowers in a field
Image credit: Richard Leeming @RM_Leeming - CC-BY license

http://nautil.us/blog/this-neural-net-hallucinates-sheep

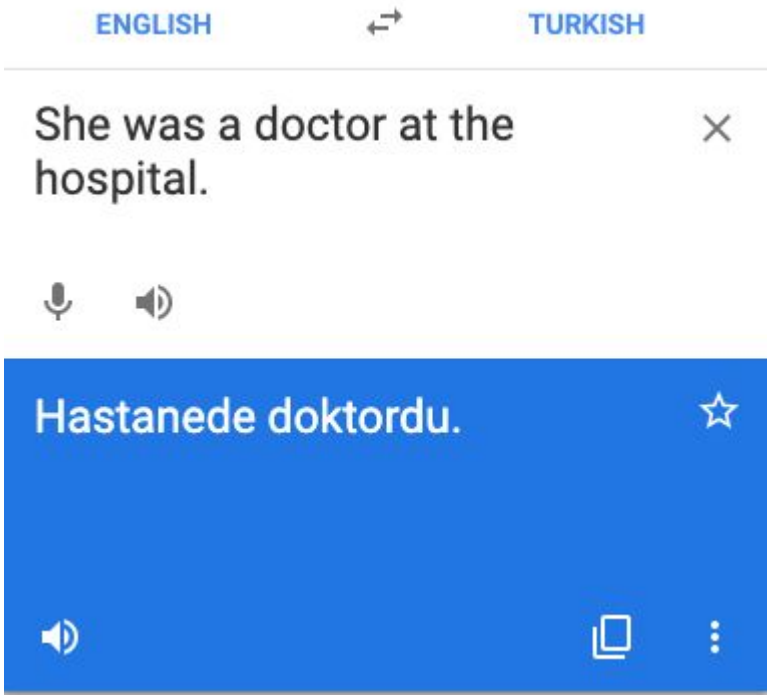
Machine Translation

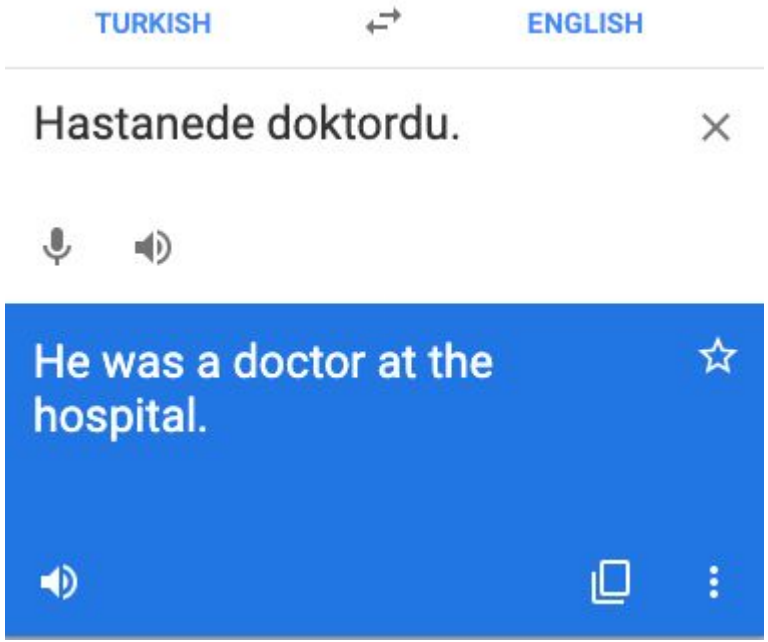
Before

After



https://ai.googleblog.com/2018/12/providing-gender-specific-translations.html


ENGLISH
TURKISH
She was a doctor at the hospital.
Hastanede doktordu.


TURKISH
ENGLISH
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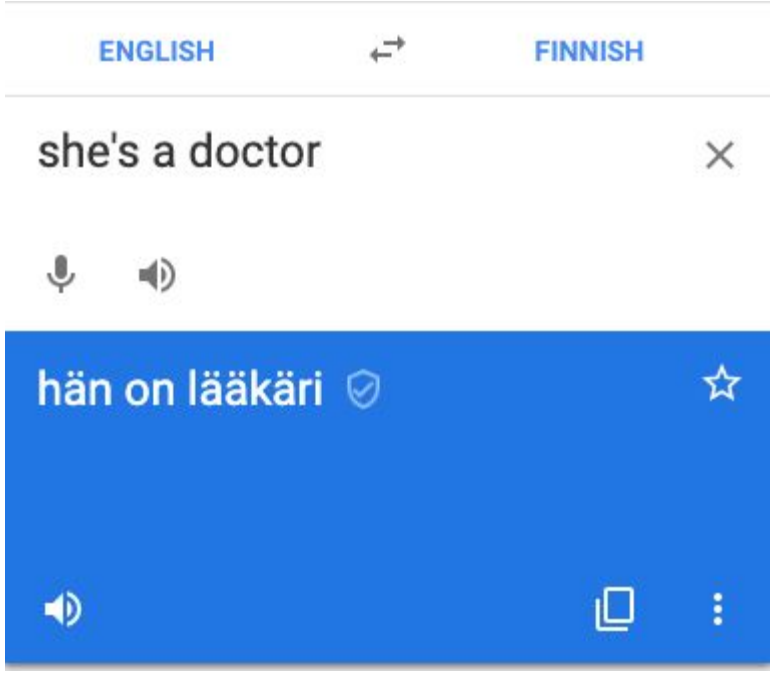
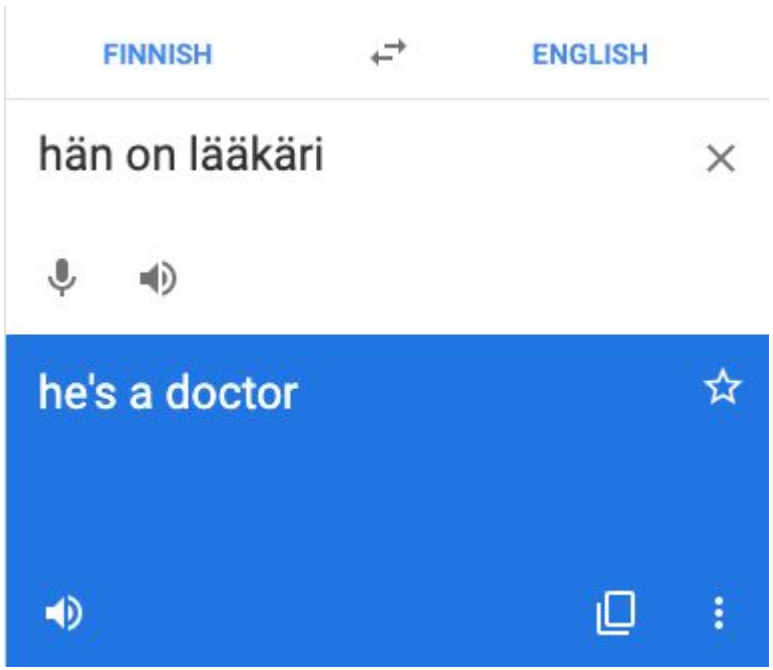

ENGLISH
FINNISH
she's a doctor
hän on lääkäri


FINNISH
ENGLISH
hän on lääkäri
he's a doctor

Language Classification

		AA Acc.	WH Acc.	Diff.
langid.py	$t \leq 5$	68.0	70.8	2.8
	$5 < t \leq 10$	84.6	91.6	7.0
	$10 < t \leq 15$	93.0	98.0	5.0
	$t > 15$	96.2	99.8	3.6
IBM Watson	$t \leq 5$	62.8	77.9	15.1
	$5 < t \leq 10$	91.9	95.7	3.8
	$10 < t \leq 15$	96.4	99.0	2.6
	$t > 15$	98.0	99.6	1.6
Microsoft Azure	$t \leq 5$	87.6	94.2	6.6
	$5 < t \leq 10$	98.5	99.6	1.1
	$10 < t \leq 15$	99.6	99.9	0.3
	$t > 15$	99.5	99.9	0.4
Twitter	$t \leq 5$	54.0	73.7	19.7
	$5 < t \leq 10$	87.5	91.5	4.0
	$10 < t \leq 15$	95.7	96.0	0.3
	$t > 15$	98.5	95.1	-3.0

Su Lin Blodgett: “Racial Disparity in Natural Language Processing: A Case Study of Social Media African-American English”, 2017; arXiv:1707.00061.

Recruiting

TECH \ AMAZON \ ARTIFICIAL INTELLIGENCE 21

Amazon reportedly scraps internal AI recruiting tool that was biased against women

The secret program penalized applications that contained the word "women's"

By James Vincent | Oct 10, 2018, 7:09am EDT

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Illustration by Alex Castro / The Verge

REUTERS

BUSINESS NEWS

OCTOBER 9, 2018 / 11:12 PM / 7 MONTHS AGO

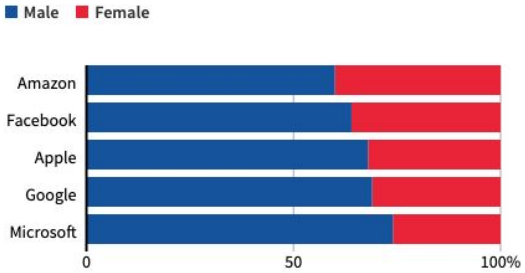
Amazon scraps secret AI recruiting tool that showed bias against women

Jeffrey Dastin

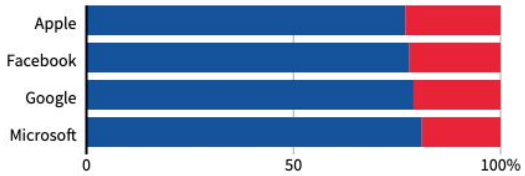
SAN FRANCISCO (Reuters) - Amazon.com Inc's (AMZN.O) machine-learning specialists uncovered a big problem: their new recruiting engine did not like women.

Top U.S. tech companies have yet to close the gender gap in hiring, a disparity most pronounced among technical staff such as software developers where men far outnumber women. Amazon's experimental recruiting engine followed the same pattern, learning to penalize resumes including the word "women's" until the company discovered the problem.

GLOBAL HEADCOUNT

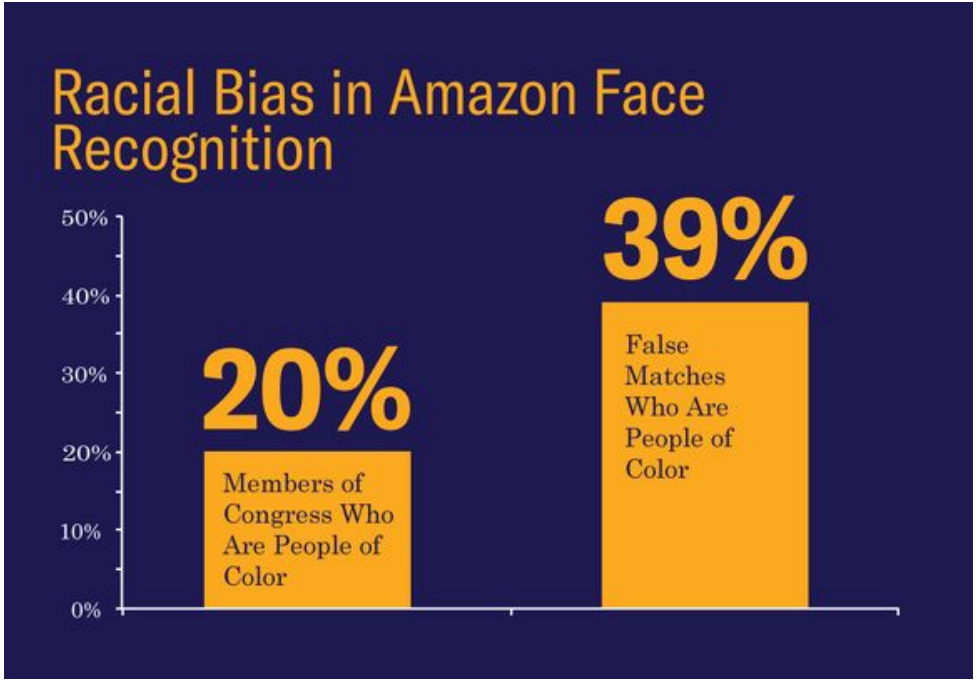


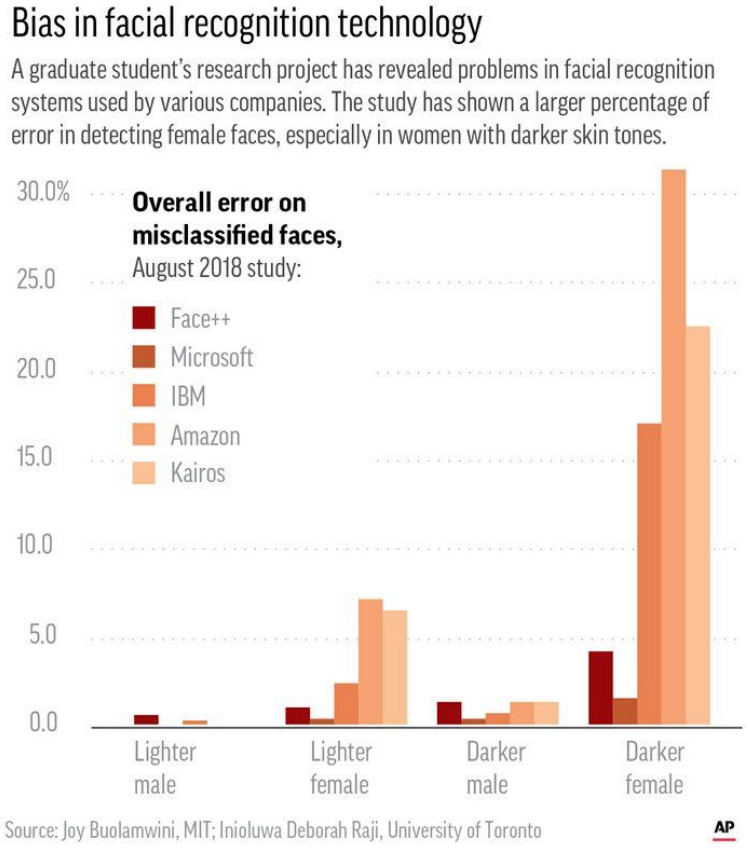
EMPLOYEES IN TECHNICAL ROLES



https://www.theverge.com/2018/10/10/17958784/ai-recruiting-tool-bias-amazon-report
https://www.reuters.com/article/us-amazon-com-jobs-automation-insight/amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-against-women-idUSKCN1MK08G

Facial Recognition





https://www.aclu.org/blog/privacy-technology/surveillance-technologies/amazons-face-recognition-falsely-matched-28
https://www.apnews.com/24fd8e9bc6bf485c8aff1e46ebde9ec1

A few more things about AI to read:

A Visual Introduction to Machine Learning @ r2d3.us

Machine Learning for Humans @ Medium

Stanford Machine Learning @ Coursera

“Deep Learning,” LeCun, Bengio, and Hinton (2015)

“Deep Learning in Neural Networks: an Overview,” Schmidhuber (2014)

Artificial Intelligence: A Modern Approach, by Russell and Norvig

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